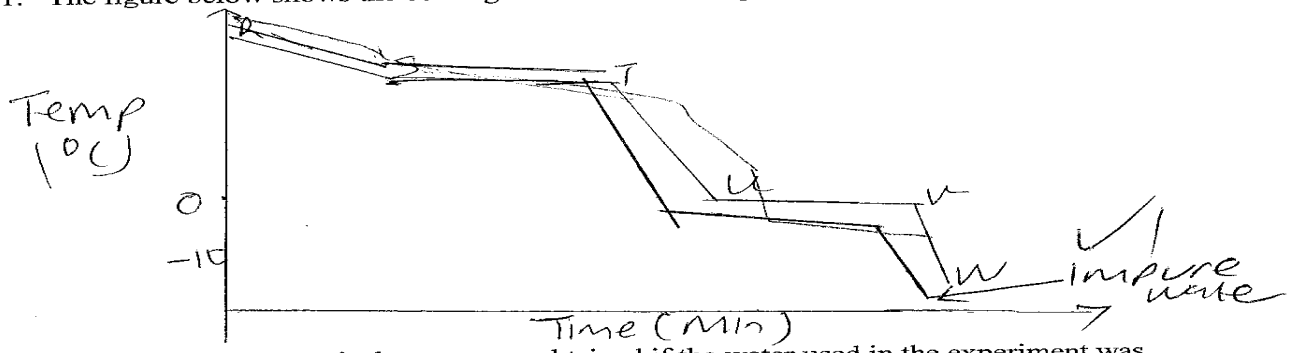
CHEMISTRY PAPER I

MARKING SCHEME

TERM 2 2019

1. The figure below shows the cooling curve for water is gaseous state.




i) Using the same axis draw a curve obtained if the water used in the experiment was impure.

(1mk)

ii) Name the process taking place between

S and T (1mk)

Condensation

U and V (1mk)

freezing



3

2. On addition of a few drops of aqeous sodium hydroxide to solution M a white precipitate forms which dissolves on a addition of excess sodium hydroxide. A white precipitate forms when solution M is reacted with sodium chloride solution. Suggest the identity of the cation present and explain. (2mks)

$Pb^{2+}$ ✓1 When $Pb^{2+}_{aq}$ react with NaOH it forms insoluble lead(II) hydroxide which dissolves in excess to form complex ions ✓½ . When reacted with Chloride ions there is formation of $PbCl_2$ ✓½

3. 1g of sodium hydroxide is added to 30cm³ of 1M HCl. How many cm³ of 0.1M KOH solution will be needed to neutralize the excess acid. (3mks)

(H=1 O=16 Na=40) ✓1

$NaOH_{(s)} + HCl_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$

Moles of NaOH = $\frac{1}{40} = 0.025$ moles ✓½

Moles of HCl = $\frac{1 \times 30}{1000} = 0.03$ moles ✓½

Moles of HCl to react with KOH

$0.03 - 0.025 = 0.005$ moles

$HCl_{(aq)} + KOH_{(aq)} \rightarrow KCl_{(aq)} + H_2O_{(l)}$ ✓1

Moles of KOH used = 0.005 moles

0.1 moles → 1000cm³ ✓½

0.005 moles → ?

$\frac{1000 \times 0.005}{0.1} = 50cm^3$ ✓1½ (4mks)

4. Describe how you can prepare crystals of magnesium chloride starting with 50cm³ of 2M magnesium hydroxide. (3mks)

Take 1000cm³ of 2M HCl ✓1 (or 2000cm³ of 1M HCl) and add to 50cm³ of 2M $MgCl_2$ in a beaker to form Magnesium Sulphate ✓½ Solution. Heat the solution to saturation and allow it to cool ✓½ for crystals to form. filter ✓½ and dry the crystals between filter papers ✓½.



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5.Use the following information to answer the questions that follow

$\Delta H_{lattice}$ $MgCl_2$ = -2489 KJ/ $mol^{-1}$

$\Delta H_{hydration}$ $Mg^{2+}$ = - 1891 kJ/ mol

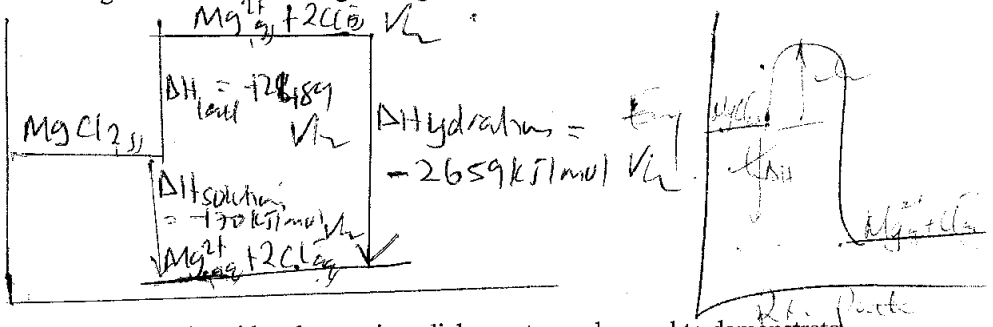
$\Delta H_{hydration}$ $Cl^-$ = -384 kJ/ mol

a) Calculate the heat of solution of magnesium chloride. (2mks)

Heat of Solution = ΔH lattice + ΔH hydration.
= +2489 + (-1891 + 2x-384) = ✓1
+2489 - 2659 = -170 KJ/mol ✓1

Penalise for sign a unit

b)Draw an energy level diagram for the dissolving of magnesium chloride. (2mks)




6.The reaction between hydrochloric acid and potassium dichromate can be used to demonstrate a reversible reaction. The ionic equation is given below

$2CrO_4^{2-}{}_{(aq)}$ + $2H^+{}_{(aq)}$ ⇌ $Cr_2O_7^{2-}{}_{(aq)}$ + $H_2O$ (l)

Yellow orange

Explain the observation that would be made when dilute hydrochloride acid is added to the equilibrium mixture. (2mks)

The orange colour intensifies ✓½ because the added H+ reduces ✓½ making the equilibrium to shift to the right ✓½ favouring forward reaction ✓½

6/

7.The table below gives the rate of decay for a sample of a radioactive element P

| Mass of P (g) | number of days |
|---|---|
| 48 | 0 |
| 18 | 90 |
| 6 | 180 |

a)Determine its half-life (2mks)

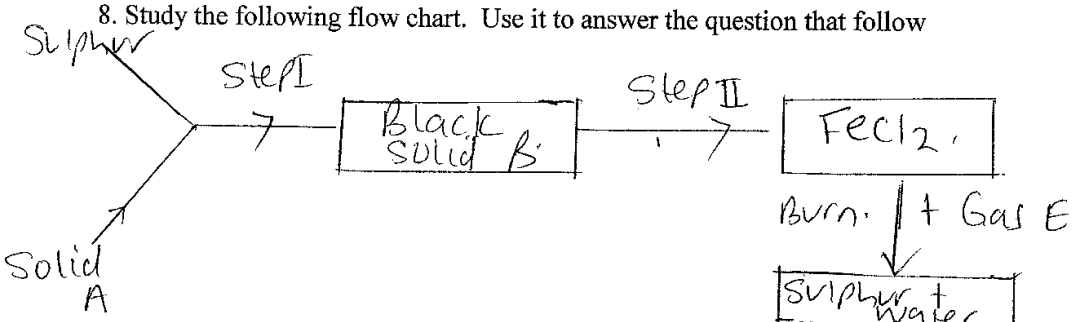
48 → 24 → 12 → 6

$3t_{\frac{1}{2}} = 180 \Rightarrow t_{\frac{1}{2}} = 60$ days

b)Complete the following nuclear equation. (1mk)

$$^{233}_{91}Pa + {}^{0}_{-1}e \longrightarrow {}^{233}_{90}Y + {}^{0}_{-1}e$$

8. Study the following flow chart. Use it to answer the question that follow




a)Identify (3mks)

i) Solid A Iron

ii)Solid B Iron (II) sulphide

iii)Gas E hydrogen sulphide

b)Name the reagents used in step (2mks)

i) I

ii) II dilute hydrochloric acid

9.i)Name two salts responsible for permanent hardness of water. (2mks)

Calcium Sulphate Magnesium Sulphate.

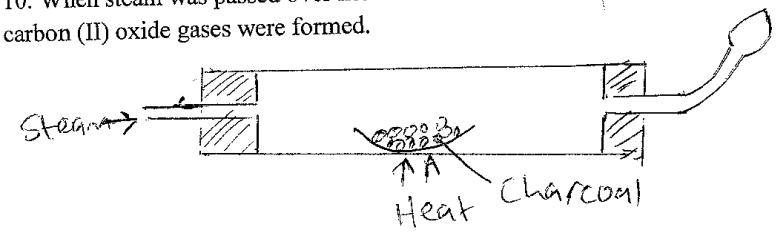
ii)Explain the precipitation method used to remove water hardness. (1mk)

Sodium Carbonate is added to precipitate $Ca^{2+}$ or $Mg^{2+}$ ion.

$Mg^{2+}_{(aq)} + CO_3^{2-}{}_{(aq)} \rightarrow MgCO_{3(s)}$ or

$Ca^{2+}_{(aq)} + CO_3^{2-}{}_{(aq)} \rightarrow MgCO_{3(s)}$.

10. When steam was passed over heated charcoal as shown in the diagram, below, hydrogen and carbon (II) oxide gases were formed.




a)Write the equation for the reaction which takes place. (1mk)

$H_2O_{(g)} + C_{(s)} \rightarrow CO_{(g)} + H_{2(g)}$

b)Name two uses of carbon (II) oxide gas which are also uses of hydrogen gas. (2mks)

1. As a fuel.
2. As a reducing agent in extraction of metals such as iron from their ore.

11.a) State and explain the observations made when a few drops of concentrated Sulphuric (vi) acid is added to sucrose ( $C_{12}O_{22}O_{11}$) (2mks)

Black mass of substance is formed.

This is because the concentrated sulphuric (VI) acid removes the atom which form water ie Hydrogen and oxygen leaving from the sucrose behind carbon which is black.

b)Using an equation show how the above reaction takes place. (1mk)

$C_{12}H_{22}O_{11(s)} \xrightarrow{\text{conc. } H_2SO_4} 12C_{(s)} + 11H_2O_{(l)}$

12.Students from Sunshine Secondary School suspected that some water contained either sulphate or sulphite ions. Explain how the ion present can be determined. (3mks)

- To a certain sample of the water, add few drops of Barium nitrate solution followed by drops of dilute nitric (V) acid. If a white precipitate soluble on addition of the acid is formed the water contains sulphite ion- and is a white precipitate insoluble on addition of the acid is formed the water contains Sulphate.

13.A mixture of ethane, oxygen and nitrogen are ignited. On cooling the residual gas occupied 58 $cm^3$ when shaken with aqeous alkali, the volume was reduced to32 $cm^3$. A further 18 $cm^3$ of the product was absorbed by alkaline pyrogallo. Calculate the composition of the original mixture. ( C = 12, H = 1, N = 14, O = 16 and molar volume at r.t.p = 24dm3. (4mks)

$2C_2H_{6(g)} + 2O_2 \longrightarrow 2CO_{2(g)} + 2H_2O_{(l)}$

Volume of $CO_2$ = 58 − 32 = 26 $cm^3$

Volum of $O_2$ = 18 $cm^3$ unreacted

Mole ratio of $CO_2$ : $C_2H_6$ = 2 : 2

13 : 26 = 1 : 2

$\frac{26 \times 1}{2}$ = 13 $cm^3$

volume of $C_2H_6$

Volum of $O_2$ used

Mole ratio of $O_2$ : $CO_2$

2 : 2

? : 26

$\frac{26 \times 2}{2}$ = 26 $cm^3$ of $O_2$ used

Total $O_2$ present = 26 + 18 = 44 $cm^3$

Original mixture

= 44 $cm^3$ − oxygen

13 $cm^3$ − Ethane

14 $cm^3$ − Nitrogen

Residue = Nitrogen + $CO_2$ + unreacted $O_2$

$O_2$ = 58 − 44 = 14 $cm^3$

58 = N + 26 + 18

58 − 44 = 14 $cm^3$

14 $cm^3$ − Nitrogen

14.0.24g of a divalent metal x dissolves in 50 $cm^3$ of 0.25 M sulphuric acid. The resulting solution required 5.0 $cm^3$ of 1.0 M sodium hydroxide solution to neutralize the excess acid. What is the reactive atomic mass of x. (3mks)

$H_2SO_{4(aq)} + 2NaOH_{(aq)} \longrightarrow Na_2SO_{4(aq)} + 2H_2O_{(l)}$

Moles of NaOH = $\frac{5}{1000} \times 1 = 0.005$ moles

Mole ratio of NaOH : $H_2SO_4$

2 : 1

0.005 : 0.0025 moles of $H_2SO_4$

$X_{(s)} + H_2SO_{4(aq)} \longrightarrow XSO_{4(aq)} + H_{2(g)}$

Available moles of $H_2SO_4$ = 0.25 × 0.05 = 0.0125 moles

Moles of $H_2SO_4$ reacted with X = 0.0125 − 0.0025 = 0.01

Mole ratio of X : $H_2SO_4$

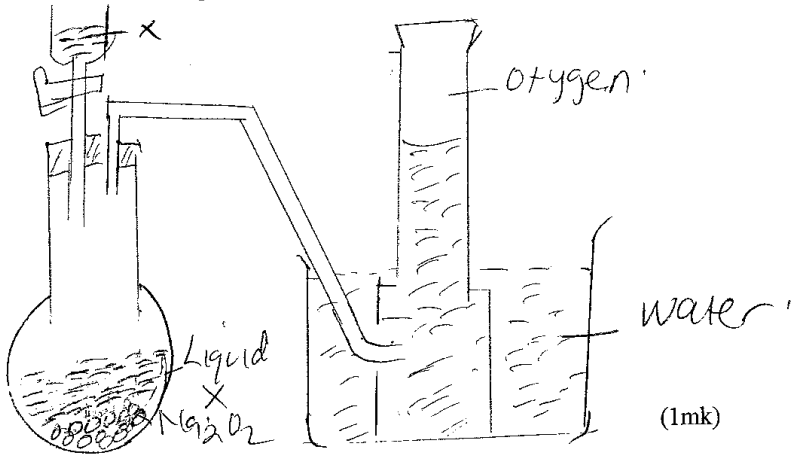
1 : 1

0.01 : 0.01

Moles = $\frac{\text{Mass}}{\text{RFM}} = \frac{0.24}{\text{RFM}} = 0.01$

RFM = $\frac{0.24}{0.01}$ = 24

15. Study the diagram below and answer the questions that follow.




a) Identify liquid x (1mk)

Water.

b) Write an equation for the reaction that occurs in the flask. (1mk)

$2Na_2O_{2(s)} + 2H_2O_{(l)} \longrightarrow 4NaOH_{(aq)} + O_{2(g)}$.

c) Describe the confirmatory test for oxygen gas. (1mk)

Insert a glowing splint to a gas jar containing the gas, If it relights the gas is confirmed to be oxygen.

16. When zinc metal is reacted with a solution of hydrogen chloride gas in water there is effervescence. When the experiment is repeated with a solution of hydrogen chloride gas in methylbenzene there is no observable change. Explain this observations. (3mks)

Solution of hydrogen chloride in water ionizes producing hydrogen ions which makes the solution acidic hence reacting with zinc to produce hydrogen gas while a solution of hydrogen chloride in methyl benzene is in molecular form hence no reaction with zinc.

17. Compare the rate of diffusion of carbon dioxide ($CO_2$) & ozone ($O_3$) at the same temperature. (C = 12, O = 16) (3mks)

$CO_2 = 12 + 32 = 44$

$O_3 = 16 \times 3 = 48$

$\frac{R_{O_3}}{R_{CO_2}} = \frac{\sqrt{44}}{\sqrt{48}}$ ✓cr

$= 0.957$ times ✓

$O_3$ diffuses 0.957 times fast $CO_2$

$\frac{R_{CO_2}}{R_{O_3}} = \frac{\sqrt{48}}{\sqrt{44}}$

$1.044$

$CO_2$ diffuses 1.044 times fast than $O_3$

18. Starting with Lead metal describe how to prepare a solid sample of Lead (II) Sulphate salt. (3mks)

- Heat Lead in air to form PbO.
- React excess PbO with dil $HNO_3$.
- Filter the excess PbO to get $Pb(NO_3)_2$ as filtrate.
- React $Pb(NO_3)_2$ with $Na_2SO_4$ / $K_2SO_4$.
- Filter to get $PbSO_4$ as the ppt.
- Dry between filter paper.

19. Given the following reaction

$HCl_{(aq)} + NaOH_{(aq)} \longrightarrow NaCl_{(aq)} + H_2O_{(l)}$

$T_1$ = initial temperature of solutions before additions = 18.0°C

$T_2$ = final temperature of solution at neutralization = 19.2°C

50 $cm^3$ 1M HCl

50 $cm^3$ 1M NaOH

Calculate Molar enthalpy of neutralization of hydrogen cyanide (3mks)

$\Delta H = MC\Delta T$

$M = (50+50)cm^3 \times 1g/cm = \frac{100}{1000} = 0.1kg$

$c = 4.2$

$\Delta T = 19.2 - 18.0 = 1.2$

$\Delta H = 0.1 \times 4.2 \times 1.2$

$= 0.504kJ$

moles of $HCl = \frac{50 \times 1}{1000} = 0.05$ moles

0.05 ≡ 0.504

$1m = \frac{0.504}{0.05}$

$= -10.08 kJmol^{-1}$

Penalize 1 for Sign

20. Compound K reacts with sodium hydroxide as shown

a)What type of reaction is represented by the equation. (1mk)

Saponification / Neutralization

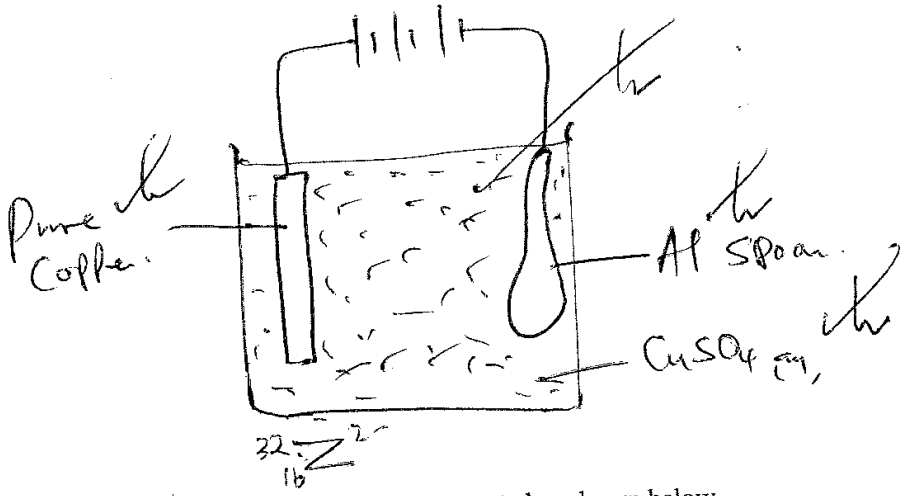
b)To what class of organic compounds does K belong. (1mk)

Carboxylic acids
Alkanoic acid

c)How is M separated from aqueous mixture of L and M. (1mk)

Adding Sodium Chloride, $C_{17}H_{35}COONa$ Precipitates

21.Draw a diagram to show how an aluminium spoon can be electroplated with pure copper. (2mks)




22.An ion of element Z can be represented as shown below,

Use the information to answer the questions that follow

a)Identify the period in which the element belong. (1/2 mk)

Period 3.

b)Write the electron configuration of the ion of Z ( ½ mk)

2.8.8

c)What would be the nature of the solution of the chloride of Z if dissolved in water. (1mk)

Acidic

23. What is $P^H$ scale (1mk)

Range of values running from 0 — 14 used to distinguish acids from bases and give their strength / weaknesses.

ii) State whether the values of the following solution are strong or weak acids and bases.

$P^H$ = 8 Weak base (~~1/2 mk~~) ½

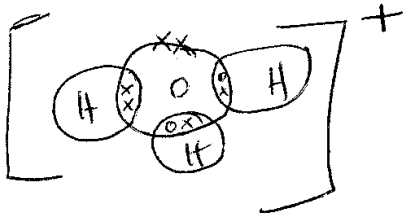
$P^H$ = 5 Weak acid (~~1/2 mk~~) ½

$P^H$ = 2 Strong acid (~~1/2 mk~~) ½

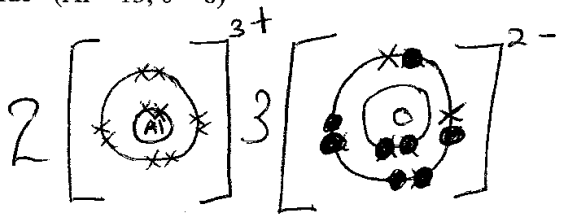
$P^H$ = 13 Strong base (~~1/2 mk~~) ½

24.Draw the structure of;

a) i) Hydroxonium ion $H_3O^+$ (1mk)




ii) Aluminium oxide (Al = 13, 0 = 8) (1mk)




b) Aluminium chloride has a melting point of 120°C while Aluminium oxide has a melting point of 2977°C. In terms of structure and bonding explain how the differences come about. (2mks)

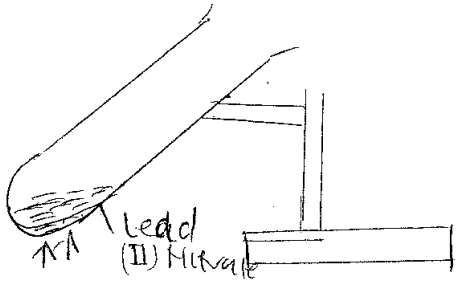
Aluminium chloride forms a dimer with Co-ordinate bonds (Covalent Compound) between the molecules which can easily dissociate with minimum heat. Aluminium oxide forms an ionic compound with strong ionic bonds throughout the structure - giant ionic structure

25.State the use of the following laboratory apparatus

i)  (1mk) used to deliver liquid substances into vessels.

ii)  (1mk) Delivers liquids drop-wise into vessels.

26.The diagram below shows heating of Lead nitrate




i)State the observations made in the above experiment (2mks)

- An orange solid left behind which turns to yellow ~~when~~ after ~~cooling~~ Cooling.
- Brown fumes at the mouth of the boiling tube.

ii) Write an equation for the reaction that takes place. (1mk)

$$2Pb(NO_3)_{2(s)} \longrightarrow 2PbO_{(s)} + 4NO_{2(g)} + O_{2(g)}$$

27.Give two differences between nuclear reactions and chemical reactions. (2mks)

| Nuclear Reactions | Chemical Reactions |
|---|---|
| 1. Takes place within the nucleus & involves protons & neutrons | Takes place within the energy levels and involves electrons ✓1 |
| 2. A lot of energy is involved | No much energy ✓1 Any 2 |
| 3. Not affected by environmental factors | Affected by environmental factors ✓1 |

12

$C = \frac{12}{44} \times 4.4 = 1.2$ ... $\frac{2}{18} = 0.22$

28. 3.1 g of an organic compound containing carbon, hydrogen and oxygen only produced 4.4 g of carbon oxide and 2.0 g of water on complete combustion:

a)Calculate its empirical formulae (2mks)

| C | H | O | |
|---|---|---|---|
| $\frac{1.2}{12}$ | $\frac{0.22}{1}$ | $\frac{1.68}{16}$ | 1½ |
| $\frac{0.1}{0.1}$ | $\frac{0.22}{0.1}$ | $\frac{0.105}{0.1}$ | |
| 1 | 2 | 1 | 1½ |

Empirical formulae $= CH_2O$ ✓1

b)Calculate its molecular formulae if its formulae mass is 62. (2mks)

$n = \frac{62}{30} = 2$ ✓1

Molecular formulae $\Rightarrow 2(CH_2O) = C_2H_4O_2$ ✓1

29. Two cleansing agents are represented below

i) $R - COO^-Na^+$ and ii) $R - OSO_3^-Na^+$

a) Name the detergents (2mks)

i) Soap ✓1

ii) Soapless detergents ✓1

b) Select one of the detergents that would be suitable for washing in water containing magnesium chloride. Explain. (2mks)

ii) $R-OSO_3^-Na^+$ ✓1 — Forms a soluble salt of Magnesium ✓1 ... scum

08

30.Use the data below to calculate the enthalpy change for the reaction below (3mks)

$CH_{4(g)} + 2O_{2(g)} \longrightarrow CO_{2(g)} + 2H_2O_{(l)}$

| Bond | Energy (KJ) |
|---|---|
| C – H | 314 413 |
| O = O | 296 ~~418~~ 489 |
| C = O | 149 805 |
| H – O | 283 464 |

O = C = O

(H – O – H)

Bond Breaking

$4(C-H) = 4 \times 314 = 1256$

$2(O=O) = 2 \times 296 = 592$

$+1848KJ$ ✓

Bond formation

$2(C=O) = 2 \times 149 = 298$

$4(H-O) = 4 \times 283 = 1132$

$-1430KJ$ ✓1

$\Delta H = +1840 - 1430$

$= +410KJ$ ✓1

Bond breaking

$4 + 413 = 1652$

$2 \times 489 = 978$ ✓1

$2630KJ$

bond formation

$2 \times 805 = 1610$

$4 + 464 = 1856$

$-3466$ ✓1

3

$2630 - 3466 = -836KJ/mol$ ✓1